

REMARKS

The above amendment is believed to have corrected typographical errors in the specification and placed the claims in proper condition for examination. Early and favorable action is awaited.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "Version with markings to show changes made."

In the event there are any additional fees required, please charge our Deposit Account No. 01-2340.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

Paragraph beginning at page 17, line 25 and ending at page 18, line 3, has been amended as follows:

Figs. 4 and 5 show an embodiment of the present invention applied to a lead-acid battery of a type provided with a tab terminal member is prepared separately and welded to the lead bushing to be led out sideways. Fig.4 is a side view thereof with the same part portion cut away as that in Fig.1, and Fig. [2] 5 is a top view of a lid.

Paragraph beginning at page 22, line 9, and ending at page 23, line 12, has been amended as follows:

In Figs.6 to 10, reference character B designates one example of a laser-welding jig according to the present invention for use in carrying out the above-mentioned laser-welding process used in the process for producing a lead-acid battery according to the present invention. A cylindrical body 70a of a cylindrical shield 70 constituting a main body of the jig B is formed into a circular one made of a metallic material having a good thermal conductivity, for instance, a metal which is high in thermal conductivity such as copper and a copper alloy, and corresponds to the mold 7 also serving as the cooling action in the previous embodiment. The cylindrical shield 70 is so constructed that an opening in the upper surface of the cylindrical body 70a is closed by a light-transmission plate 5 permeable to a laser beam, in general, by a heat-resistant glass plate 5, and the lower end portion thereof is formed into a cylindrical lower end portion 70a1 having the inner diameter suitable being fitly mounted on the outer peripheral surface of a terminal portion of a lead-acid battery. Further, the plural number, preferably, three or more of discharge openings 14,14,... are disposed at regular intervals and circumferentially so as to made open at the lower portion of the cylindrical body 70a, as shown in Figures, and furthermore, a shroud ring 16 which is provided with the plural number,

for example, six of communication openings 15,15,... in the illustrated embodiment, positioned above the discharge openings 14,14, ... and disposed at regular intervals and circumferentially, is installed in the cylindrical shield [1] 70 so that an annular space 17 may be left between the shroud ring 16 and the inner surface of a peripheral wall of the cylindrical shield 70, and an exhaust port 18, preferably, a tubular exhaust port 18 as shown in the Figures is provided in a protruding fashion in the cylindrical shield 70 to communicate with the annular space 17.

Paragraph beginning at page 23, line 13, and ending at page 24, line 21, has been amended as follows:

More specifically, the illustrated cylindrical shield 70 is formed with a relatively thick cylindrical wall 70a3 of 5 ~ 10 mm in thickness, and the lower portion thereof is so formed into a tapered cylindrical wall 70a2 that its diameter is reduced gradually toward a cylindrical lower end portion 70a1, and the foregoing three discharge openings 14,14,14 are made in the tapered cylindrical wall 70a2 so that they may be inclined downwards from an outer end to an inner end of each thereof and open in the vicinity of an opening in the cylindrical lower end portion 70a1, and, in use, oxygen or air may be discharged at a desired discharge pressure from an external compression pump (not shown), through a pressure hose 19 air-tightly connected by a collet-chuck means to the each discharge opening 14, into the cylindrical shield 70 toward the open surface of the cylindrical lower end portion 70a1. The inner peripheral wall surface of the upper cylindrical wall 70a3 of the cylindrical shield 70 is formed into a notched wall surface of an L-shape in section for installing the shroud ring 16 of a U-shape in cross section, and the shroud ring 16 is installed in a recess portion in an inner periphery of the notched wall surface so that an annular space 17 may be formed between the recessed groove of the U-shape of the shroud ring 16 and the notched wall surface surrounding the outer periphery of the shroud ring. Further, a wide annular shield cap 20 of a T-shape in cross section is threadedly mounted on and is interposed between a top surface of the upper cylindrical

wall 70a3 of the cylindrical shield 70 and a top surface of the shroud ring 16 located inside and at the same level as the top surface of the upper cylindrical wall 70a, so that the shroud ring 16 is retained and fixed by pressing the upper and lower portions thereof by the cylindrical shield 70 and the annular shield cap 20. An opening in the upper surface of the annular shield cap [19] 20 is closed by a disk-shaped glass plate 5', and it is jointed air-tight by sandwiching the peripheral edge thereof between the shroud ring 16 and the annular shield cap 20 through an annular packing 21 interposed there between, and thus the welding jig B is constructed.

Paragraph beginning at page 25, line 14, and ending at page 26, line 5, has been amended as follows:

The lower cylindrical end portion 70a1 of the cylindrical shield 70 of the jig B according to the present invention is fitly mounted on the outer peripheral surface of a terminal portions T comprising an upper end portion 1a of a lead bushing 1 cast in a container lid b'', made of a synthetic resin in a lead-acid battery A'', and an upper end portion 2a of a positive or negative pole, e.g., of a positive pole 2 in the illustrated embodiment inserted through an insertion hole 3 of the lead bushing 1, and in other words, on an outer peripheral surface of the upper end 1a of the lead bushing [2] 1, and therefore the inside of the cylindrical shield 70 is made airtight. On the other hand, the discharge openings 14,14,14 disposed in the lower portion of the cylindrical shield 70 are connected to an external common compression pump (not shown) through the connecting tubes 19,19,19 such as a pressure tube, and the tubular exhaust port 18 protruding from the side surface of the upper portion of the cylindrical shield 70 is connected to the external vacuum pump {not shown} through the connecting tube 21 such as a pressure tube.

Paragraph beginning at page 26, line 6, and ending at page 27, line 4, has been amended as follows:

A laser nozzle 4 led out, for example, from a pulsed type laser generator {not shown} is so positioned above the jig B placed on the battery lid b', surrounding the terminals T, as described above, so that a laser beam 4b may be directed as shown by an arrow, through an incident lens within the laser nozzle 4 toward a target of the portions to be welded, i.e., toward one point of mutually abutted circular portions 8 constituting the terminal portions T composed of a projection 1a['] of a lead bushing 1['] and an upper portion of either a negative or a positive pole, that 2a['] of the positive pole 2 ['] in the illustrated example, inserted through the insertion bore in the lead bushing 1'. At this time, the distance between the portions 8 to be welded and the laser nozzle 4 is set to be equal to a focal distance of the incident lens within the laser nozzle 4. In the case of application of the laser beam, the laser nozzle 4 is moved round at a radius equal to the radius of the circular portions 8 to be welded, thereby applying the laser beam at least one round to the entire circumference of the portions 8 to be welded, thus welding the portions 8 together. In this case, the application conditions of the laser beam are, for example, such that a quantity of application heat is in a range of 5 ~ 10 Joules/pulse and that the application intervals are in a range into the cylindrical shield 70 is sucked to be exhausted together with the generated fumes as an exhaust gas. The heat of the bushing 1 rising in temperature during the welding is removed simultaneously with the exhaustion of the gas, so that the temperature of the bushing 1 can be correspondingly lowered to satisfactorily prevent the softening and fusion of the resin around the bushing 1.

Paragraph beginning at page 28, line 8, has been amended as follows:

In this case, when the communication openings 15,15,... are made in the circumferentially tangent direction in the shroud ring 16 as mentioned above, an eddy flow is caused to occur in the flow of the exhaust gas, and the exhaust gas can be sucked to be exhausted smoothly and quickly as a flow in a given definite direction. Thus, the discharge amount of the shielding fluid to be flowed into the cylindrical shield 70 through the discharge opening 14 and the exhaust amount of the

shielding fluid to be sucked and exhausted is adjusted as desired to any of various values and a desired preferable laser welding can be carried out. For this purpose, the discharge pressure and discharge flow rate of the shielding fluid by the compression pump and the exhaust pressure and exhaust rate of the exhaust fluid by the vacuum pump are adjusted to any of various values, and particularly, it is preferable to set the discharge pressure in a range of 60 ~ 80 Kpa, the discharge flow rate in a range of 15 ~ 20 liters/min, the [discharge] exhaust pressure in a range of 300 ~ 450 Pa and the exhaust flow rate in a range of 4 ~ 5 m³/min.

Paragraph beginning at page 33, line 22, and ending at page 35, line 6, has been amended as follows:

--Thus, the laser welding is carried out in such a state that the lower cylindrical end 70a1'' of the laser-welding jig B'' is fitly mounted on the annular notched step 1b provided on the outer peripheral surface of a terminal T, in other words, on the outer peripheral surface of the protrusion 1a of the lead bushing 1 thereof, and, in the illustrated embodiment, a laser nozzle 4 is so positioned so that a laser beam 4b converged by a condenser lens 4c may be focused to hit on the outer side portion about 0.15 mm from the boundary of the annular abutted portions 8 (with a gap of 0 ~ 0.5 mm left therebetween) between the outer peripheral surface of the pole 2 and the inner peripheral surface of the lead bushing [2]1, and in other words, the laser beam 4b may hit on the inner peripheral edge of the lead bushing 1. And laser nozzle 4 is moved round along the inner peripheral edge of the lead bushing so that the laser beam 4b thereof may be applied thereto and, meanwhile, the evacuation by suction is conducted through the exhaust tube 21' and the connecting tube 22'. The laser welding is carried out in the above-mentioned manner that the laser beam of such a low output that generates no sputtering, was made one round and thereafter the laser beam of a high output was made one round. Thus, the laser welding between the pole 2 and the lead bushing 1 can be welded to each other satisfactorily with a uniform depth over the entire circumference. In the case, when the laser beam of the high output is made one round, it is of course that it is made one round either

at a uniform or definite high output or by reducing a high output stepwise at the plural number of stages. According to the present embodiment, the open air is sucked into the cylindrical shield 70' through the air-intake openings 23,23,... by the above-mentioned suction evacuation action and always exhausted to the outside through the cylindrical shield 70' while carrying the fume generated in the laser welding, so that the protection glass 5 can prevent the fumes from adhering thereto and accordingly, not only the portions X to be welded can be welded together satisfactorily with a predetermined high energy and with a predetermined good depth without intercepting the laser beam, but also there is accompanied by such an effect that the lead bushing 1 heated during welding is air-cooled by the sucked exhaust current.

IN THE CLAIMS:

Claims 4, 5, 7, 8, 9, 11, 13 and 15, have been amended as follows:

4. (Amended) A process for producing a lead-acid battery according to claim 1[, 2 or 3] or 2, wherein the pole is provided with a columnar projection or a hollow cylindrical projection at the center of the upper end surface thereof.

5. (Amended) A process for producing a lead-acid battery according to [claims 1 to 4] claim 1 or 2, wherein at the time of the laser welding, a laser beam of a low output is applied and thereafter a laser beam of a high output is applied.

7. (Amended) A process for producing a lead-acid battery according to [any of claims 1 to 6] claim 1 or 2, wherein the laser welding is of a pulsed type.

8. (Amended) A process for producing a lead-acid battery according to [any of claims 1 to 7] claim 1 or 2, wherein a lap density of beads in the laser welding of a pulsed type is in a range of 6 to 12 points per mm.

9. (Amended) A process for producing a lead-acid battery according to [any of claims 1 ~8] claim 1 or 2, wherein at the time of laser-welding by applying the laser to terminal portions to be welded of the lead-acid battery, there is used such a process for laser-welding of the terminal portions that the terminal portions are surrounded by a lower cylindrical end portion of a cylindrical shield, and, in this state, fumes generated at the time of the laser-welding are sucked to be exhausted to the outside of the cylindrical shield through the exhaust port in the cylindrical shield.

11. (Amended) A process for producing a lead-acid battery according to claim 9 [or 10], wherein there is used such a process for laser-welding of the terminal portions that a shroud ring having the plural number of communication openings provided circumferentially in its peripheral wall is installed in the cylindrical shield with an annular space being left between the shroud ring and the inner peripheral wall surface of the cylindrical shield so that fumes generated in the shroud ring may be sucked to be exhausted out of the cylindrical shield through the communication openings of the shroud ring, the annular space surrounding thereof and the exhaust port, together with a shielding fluid flowed through the discharge opening into the cylindrical shield.

13. (Amended) A process for producing a lead-acid battery according to claim 9 [or 12], wherein there is used such a process for laser-welding of the terminal portions, wherein an annular notched step is provided on a peripheral outer surface of the lead bushing defining an outer peripheral surface of the terminal portions, and the lower cylindrical end portion of the cylindrical shield having a good heat-conductivity is fitly mounted on the step thereof.

15. (Amended) A laser-welding jig according to claim 14, wherein the cylindrical shield is provided with a plurality of air-intake openings disposed at an upper portion thereof, and the exhaust port communicating with the annular space is made in the side of the cylindrical shield below the air-intake openings.

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